

Globus Data Grid Protocols and Services

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the globus project
www.globus.org

The Problem

“Enable a geographically distributed community [of thousands] to perform sophisticated, computationally intensive analyses on Petabytes of data”



Example Application Scenarios

- Climate community
 - Sharing, remote access to and analysis of Terascale climate model datasets
- GriPhyN (Grid Physics Network)
 - Petascale Virtual Data Grids
- Distance visualization
 - Remote navigation through large datasets, with local and/or remote computing



Data Intensive Issues Include ...

- Harness [potentially large numbers of] data, storage, network resources located in distinct administrative domains
- Respect local and global policies governing what can be used for what
- Schedule resources efficiently, again subject to local and global constraints
- Achieve high performance, with respect to both speed and reliability
- Catalog software and virtual data

Data Intensive Computing and Grids

- The term “Data Grid” is often used
 - Unfortunate as it implies a distinct infrastructure, which it isn’t; but easy to say
- Data-intensive computing shares numerous requirements with collaboration, instrumentation, computation, ...
- Important to exploit commonalities as very unlikely that multiple infrastructures can be maintained
- Fortunately this seems easy to do!

Examples of Desired Data Grid Functionality

- High-speed, reliable access to remote data
- Automated discovery of “best” copy of data
- Manage replication to improve performance
- Co-schedule compute, storage, network
- “Transparency” wrt delivered performance
- Enforce access control on data
- Allow representation of “global” resource allocation policies

Central Q: How must Grid architecture be extended to support these functions?



Grid Protocols, Services, Tools: Enabling Sharing in Virtual Organizations

- Protocol-mediated access to resources
 - Mask local heterogeneities
 - Extensible to allow for advanced features
 - Negotiate multi-domain security, policy
 - “Grid-enabled” resources speak protocols
 - Multiple implementations are possible
- Broad deployment of protocols facilitates creation of Services that provide integrated view of distributed resources
- Tools use protocols and services to enable specific classes of applications



"Data Grid" Architecture Elements

A P P L I C A T I O N S

Task mgmt
(Condor-G)

Data request
management

...

Caching

Virtual
Data

Reliable
replication

Replica
selection

Attribute-based
lookup

Location
cataloging

Metadata
cataloging

...

Virtual Data
cataloging

Enquiry (LDAP)
Access (GRAM)

CPU

CPU
resource
manager

Enquiry (LDAP)
Access (???)

Stor
age

Storage
resource
manager

...



The Globus Data Grid Services

Two major components:

1. Data Transport and Access

- Common protocol
 - Secure, efficient, flexible, extensible data movement
- Family of tools supporting this protocol

2. Replica Management Architecture

- Simple scheme for managing:
 - multiple copies of files
 - collections of files

APIs, white papers: <http://www.globus.org>



Motivation for a Common Data Access Protocol

- Existing distributed data storage systems
 - DPSS, HPSS: focus on high-performance access, utilize parallel data transfer, striping
 - DFS: focus on high-volume usage, dataset replication, local caching
 - SRB: connects heterogeneous data collections, uniform client interface, metadata queries
- Problems
 - Incompatible protocols
 - > Each require custom client
 - > Partitions available data sets and storage devices
 - Each protocol has subset of desired functionality



A Common, Secure, Efficient Data Access Protocol

- Common, *extensible* transfer protocol
- Decouple low-level data transfer mechanisms from the storage service
- Advantages:
 - New, specialized storage systems are automatically compatible with existing systems
 - Existing systems have richer data transfer functionality
- Interface to many storage systems
 - HPSS, DPSS, file systems
 - Plan for SRB integration



Common Data Access Protocol and Storage Resource Managers

- Grid encompasses “dumb” & “smart” storage
- All support base functionality
 - “Put” and “get” as essential mechanisms
 - Integrated security mechanisms, of course
- Storage Resource Managers can enhance functionality of selected storage systems
 - E.g., progress, reservation, queuing, striping
 - Plays a role exactly analogous to “Compute Resource Manager”
- Common protocol means all can interoperate



And the Universal Protocol is ... Grid-FTP

- Why FTP?
 - Ubiquity enables interoperation with many commodity tools
 - Already supports many desired features, easily extended to support others
 - Well understood and supported
- We use the term Grid-FTP to refer to
 - Transfer protocol which meets requirements
 - Family of tools which implement the protocol
- Note Grid-FTP > FTP
- Note that despite name, Grid-FTP is not restricted to file transfer!



Grid-FTP: Basic Approach

- FTP is defined by several IETF RFCs
- Start with most commonly used subset
 - Standard FTP: get/put etc., 3rd-party transfer
- Implement standard but often unused features
 - GSS binding, extended directory listing, simple restart
- Extend in various ways, while preserving interoperability with existing servers
 - Striped/parallel data channels, partial file, automatic & manual TCP buffer setting, progress monitoring, extended restart



The Grid-FTP Family of Tools

- Patches to existing FTP code
 - GSI-enabled versions of existing FTP client and server, for high-quality production code
- Custom-developed libraries
 - Implement full GSI-FTP protocol, targeting custom use, high-performance
- Custom-developed tools
 - Servers and clients with specialized functionality and performance

Replica Management

- Maintain a mapping between logical names for files and collections and one or more physical locations
- Important for many applications
 - Example: CERN HLT data
 - > Multiple petabytes of data per year
 - > Copy of everything at CERN (Tier 0)
 - > Subsets at national centers (Tier 1)
 - > Smaller regional centers (Tier 2)
 - > Individual researchers will have copies



Our Approach to Replica Management

- Identify replica cataloging and reliable replication as two fundamental services
 - Layer on other Grid services: GSI, transport, information service
 - Use LDAP as catalog format and protocol, for consistency
 - Use as a building block for other tools
- Advantage
 - These services can be used in a wide variety of situations

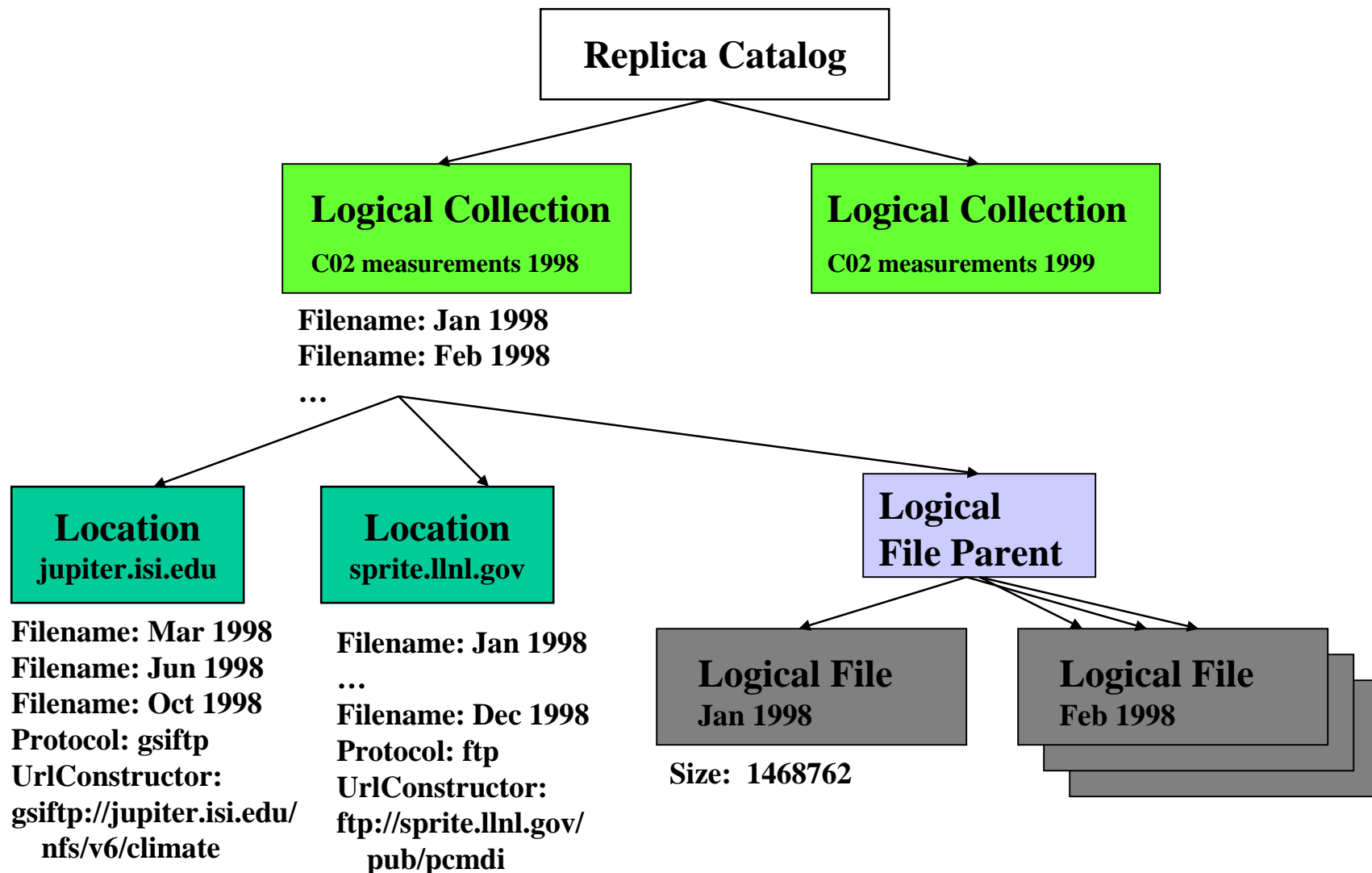


Replica Manager Components

- Replica catalog definition
 - LDAP object classes for representing logical-to-physical mappings in an LDAP catalog
- Low-level replica catalog API
 - globus_replica_catalog library
 - Manipulates replica catalog: add, delete, etc.
- High-level reliable replication API
 - globus_replica_manager library
 - Combines calls to file transfer operations and calls to low-level API functions: create, destroy, etc.

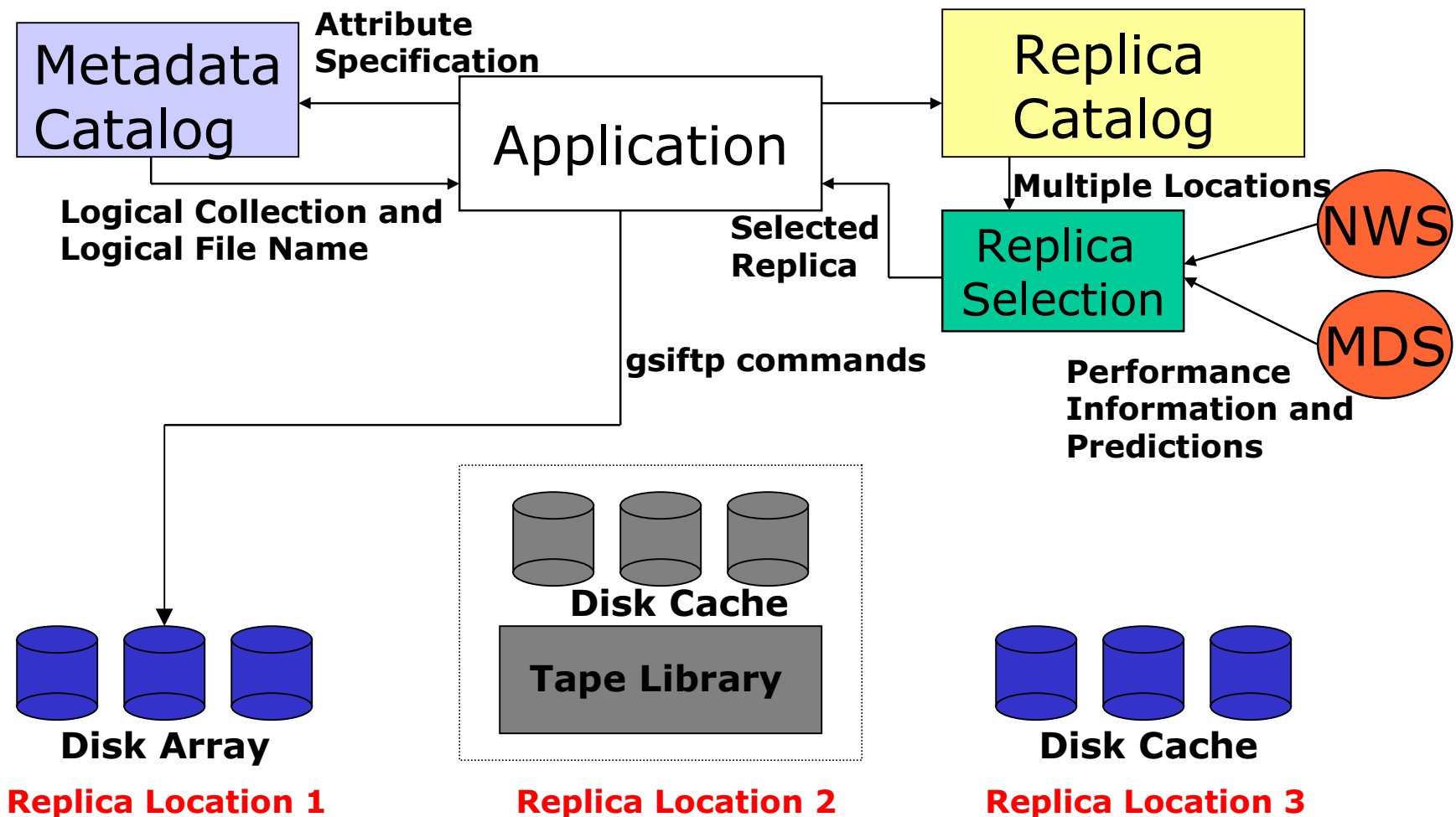


Replica Catalog Structure: A Climate Modeling Example





A Model Architecture for Data Grids



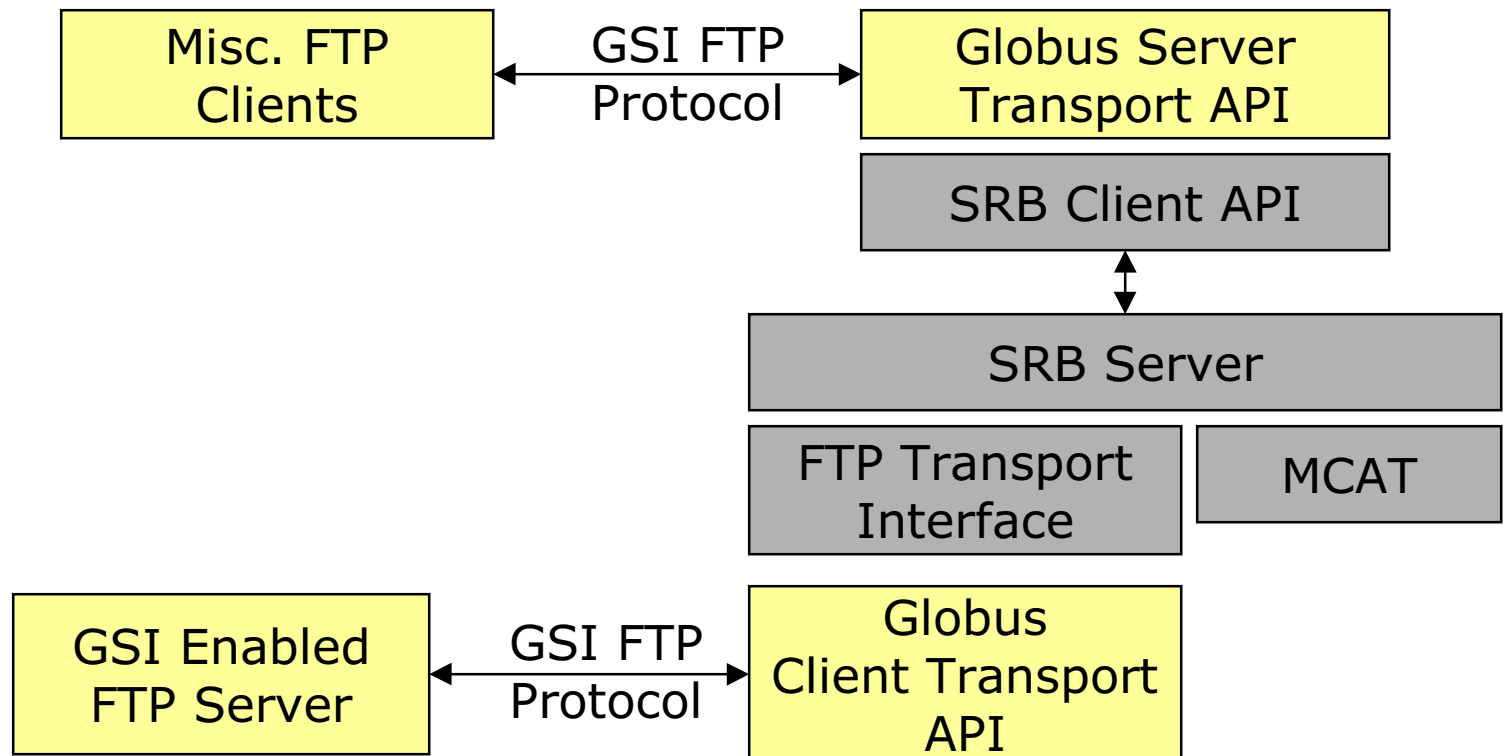


Relationship to Metadata Catalogs

- Metadata services describe data contents
 - Have defined a simple set of object classes
- Must support a variety of metadata catalogs
 - MCAT being one important example
 - Others include LDAP catalogs, HDF
- Community metadata catalogs
 - Agree on set of attributes
 - Produce names needed by replica catalog:
 - > **Logical collection name**
 - > **Logical file name**

Globus and SRB: Integration Plan

- FTP access to SRB-managed collections
- SRB access to Grid-enabled storage systems



Status

- Grid FTP and catalog management API and tools in alpha test
- Demonstration applications with climate data
- SRB/Globus data grid services integration underway
- Replica Management API under design
- Grid based access control strategy under design